Sustainable Building Design

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Interagency Sustainability Working Group
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What is "Sustainable Design?"

- Sustainable development is:
  - Developing the built environment while considering
    - Environmental responsiveness
    - Resource efficiency
    - Community sensitivity
  - Addressing business issues in addition to social and environmental issues
- Sustainable building design is:
  - Creating buildings where all components (e.g., architecture and engineered systems) work in unison as a single ***system***
  - Effectively integrating energy efficiency and passive solar design strategies such that minimal renewable energy resources can exceed the building's remaining energy needs

LANL Vision for Sustainable Design

LANL committed to employing design and construction approaches that:

- Maximize productivity within the built environment
- Minimize impact to the natural environment
- Assure good stewardship of public funds and resources

DOE Order 430.2A

- Requires incorporating sustainable design principles in new buildings of 10,000 gross ft^2 or greater
- Minimum elements of report required at the conclusion of Title II design are:
  - energy efficiency compliance with 10CFR434
  - Site responsiveness
  - Water conservation
  - Materials sensitivity
  - Healthiness
  - Environmental releases

Guide for the Laboratory's Physical Development

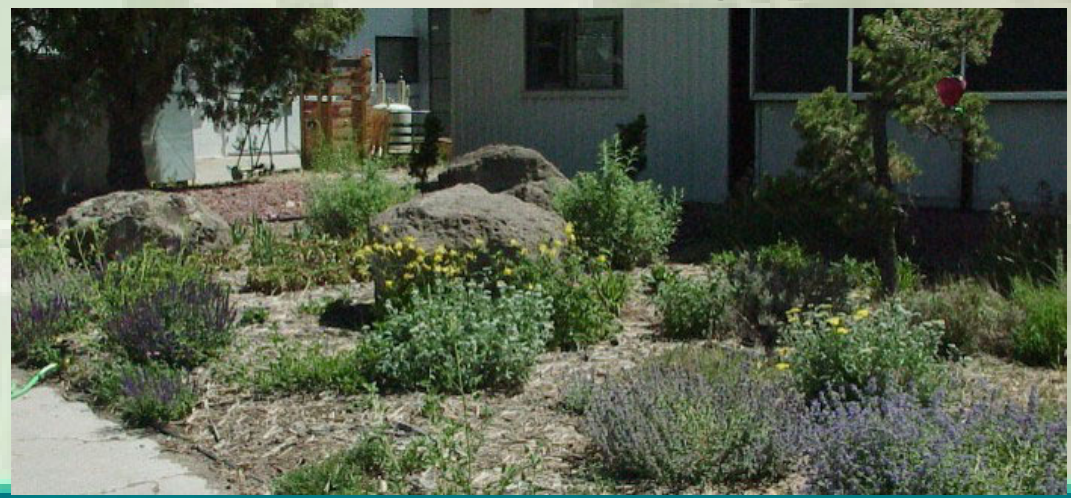
- Scope
  - Building envelope, interior functions, and all other aspects of the building design that can affect the building's overall environmental impact.
- Format
  - Order of presented guidance follows conventional design process
  - Guidance includes entire design and construction process

Demonstrate Leadership in Sustainable Building Design

- American Planning Association 2002 Planning Award—Outstanding Sustainable Planning or Design Project
- Federal agencies and national laboratories expressing interest
  - National Renewable Energy Laboratory
  - US Air Force
  - US Coast Guard
  - Department of Commerce
  - Interagency Sustainability Working Group

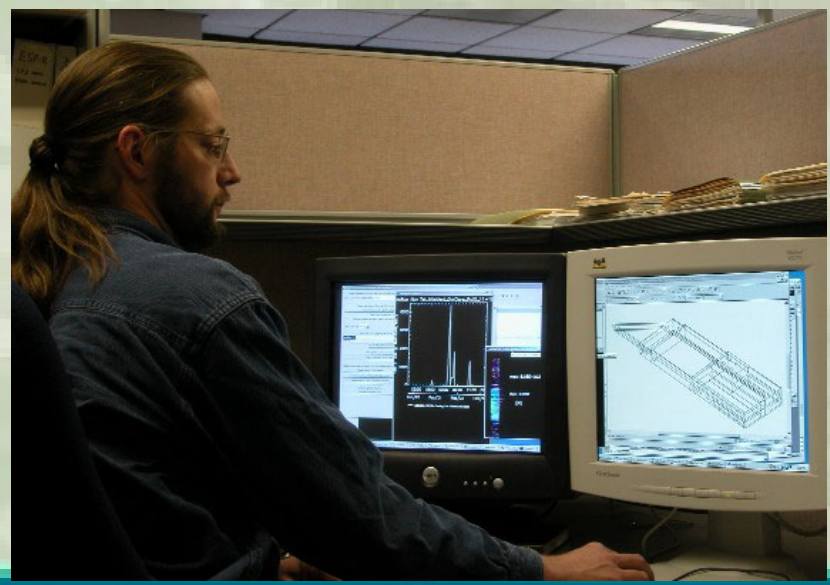
Topics Addressed in the *LANL SDG*

- Whole-building design
- Building siting
- Building architectural design
- Lighting, HVAC, and Plumbing Systems Design
- Materials
- Exterior landscape design and management
- Constructing the building
- Building commissioning
- Education/training/operation

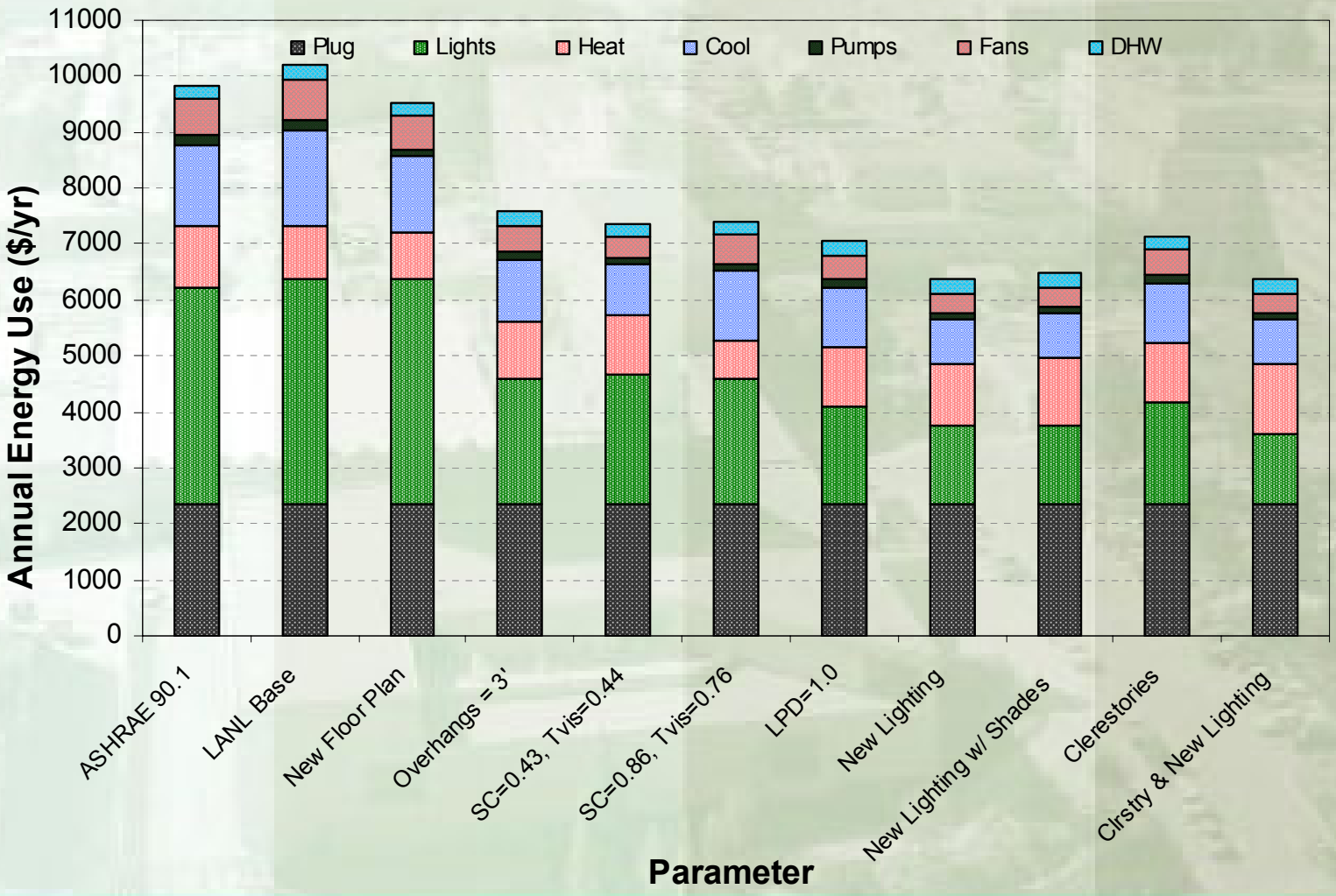


Computer Simulations

- **Pre-design** – identify/prioritize envelope energy-efficiency strategies
- **Schematic** – determine building massing, fenestration, and envelope construction
- **Design** – evaluate/select HVAC&L systems/controls to complement the envelope design
- **Construction** – evaluate how changes affect performance
- **Commissioning** – establish baseline performance for commissioning by simulating the as-built design
- **Post-occupancy** – update simulation to reflect operation and use pattern changes



Daylighting Strategy Analysis



High-Performance Architectural Design

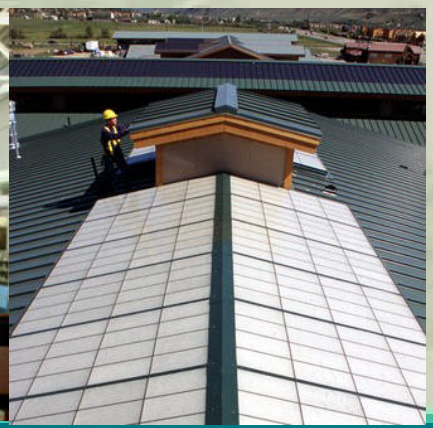
The architecture itself provides comfort for the occupants

- Maximize use of daylight while maintaining visual comfort
- Minimize solar gains when the building is in cooling mode
- Utilize solar gain when the building is in heating mode
- Cluster spaces with similar thermal needs
- Facilitate natural ventilation
- Plan for good solar access for solar thermal and PV systems arrays

Designing for Daylighting

- Place windows high for deep daylighting penetration
  - Penetration = 1.5 * (height of the window from floor)
- Bright surface reflectances essential
  - Ceiling > 90%; walls 50-70%; floors 20-40%; furnishings 24-45%
- Light shelves increase daylighting penetration
- Design top lighting strategies to avoid glare/overheating



Solar Load Control Strategies

- Important in ALL climates,
  - uncontrolled solar gain leads to high cooling loads, excessive illumination, and excessive glare
- Size windows for best daylighting and passive heating
  - additional windows only for view, do not overglaze
- Exterior shading devices on south windows
- Carefully select glazing properties
- Interior shading devices to control glare

Passive Solar Systems

- No moving parts or input energy
- Requires little/no maintenance or user control
- Emits no harmful pollution or waste by-products
- Passive solar system examples
  - Trombe Wall
  - Passive cooling
  - Natural ventilation
  - Evaporative cooling with cool towers

Active Solar and PV Systems

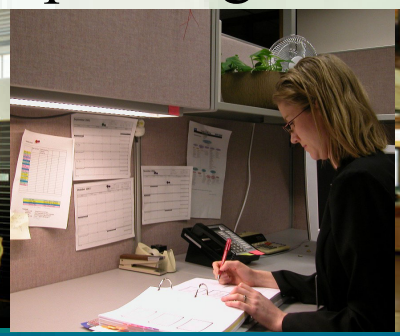
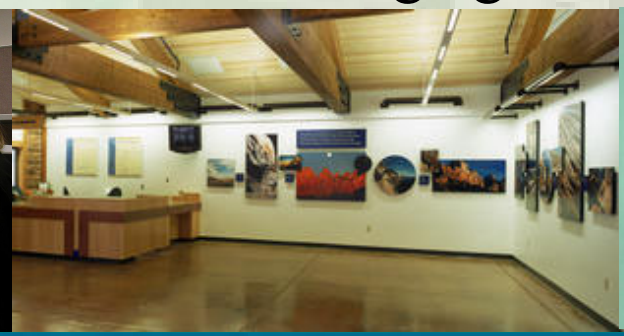
- Active solar systems circulate water or air conditioned by solar energy to meet space or process loads
  - Solar hot water
  - Transpired solar collectors
- Solar-electric (photovoltaic) systems convert sunlight into electrical energy

High-Performance Engineering Design

The architectural design maximizes the potential for a high-performance building, but it is the engineering design that actually makes the building a high-performance building.

Lighting System Design

- Provide the appropriate lighting system type
  - Ambient lighting (can offset with daylight)
  - Task lighting
  - Accent lighting
  - Safety/security lighting
- Operate electric lighting only when insufficient daylighting available and the space is occupied
  - Lighting system controls should dynamically respond to varying daytime lighting levels
- Select continuous dimming or on/off (step) controls
- Verify operating W/ft^2 to ensure design goal compliance


Mechanical System Design

- Identify HVAC system zones
  - Use computer simulations to calculates zone loads
  - Minimize loads in perimeter and interior zones
  - Group spaces with similar functions and similar loads into a single zone
  - Use demand-controlled ventilation with CO_2 sensing
- Satisfy zone temperature and humidity requirements with least energy
  - VAV systems
  - Air distribution systems
  - "Free" cooling systems
  - Evaporative cooling systems
  - Ventilation exhaust systems
  - Air-to-air energy recovery systems
- Central plan equipment selection
  - Multiple chillers/boilers
  - Chillers with high integrated part-load value and variable-speed drives
  - Combined heat and power systems

Water Efficiency

- Water efficiency measures can reduce water use by 30%
- Select plumbing fixtures that exceed EPACT requirements
  - Use sensing devices to operate faucets, toilets, and urinals
  - Specify waterless urinals
- Wastewater reduction alternatives
  - Use multi-pass, recirculation, or air-cooled chiller systems
  - Eliminate use of once-through cooling systems
  - Use condensate and blowdown water for other non-potable water consuming applications
  - Connect equipment to a closed-loop system rather than using potable water

Energy Management Control Systems and Metering

- Optimize equipment start and stop times
- Operate equipment at the minimum capacity necessary
  - Avoids conflicts between equipment operation
- Limit peak electric demand
- Provide ability to record equipment operation data for building performance monitoring
- Comply with “Site Wide Metering Program at LANL” and follow 10CFR434 metering guidance
  - Install permanent sub metering equipment for measuring lighting loads, HVAC system loads, and equipment loads of more than 20 kW
  - Separately meter ventilation fan use and cooling plant use for large buildings with complex HVAC systems
  - Install gas meters for all buildings with gas service
  - Install water meters for all buildings with water service
  - Separately meter large process (gas or water) or cooling tower (water) loads

Materials

- Environmentally preferable (EP) construction materials have a reduced environmental impact
- Environmental impacts of construction materials may include:
  - pollutant releases
  - habitat destruction
  - depletion of natural resources

Landscape Design and Management

- Sustainable landscape design helps protect the regional watershed while enhancing the sustainability of the site
- Stormwater management – goal: generate no additional runoff from the site compared with pre-development conditions
  - Infiltration basis
  - Bioretention swale
  - Dry extended detention pond
- Reduce landscape water use
  - Native plant species
  - Efficient irrigation practices
  - Recycled water/rainwater harvesting

Constructing the Building

- Goal—construct the building so it will perform as intended and protect the environment as much as possible during construction
- Set construction guidelines early to ensure goal is met
- Protect the construction site
  - Designate site storage destinations for all construction materials
  - Avoid damaging existing vegetation
- Implement low-impact construction and waste management practices
- Protect IAQ during construction

Commissioning and Documentation

- Owner's requirements
- Commissioning plan
- Design review
- Bid documents
- Prefunctional checklists
- Functional performance test procedures and checklists
- Commissioning report
- Training
- Operation and maintenance manuals
- Recommissioning management manual
- Post-occupancy optimization report

Education, Training, Operation

- Success of a high-performance building depends on how it is designed, built, and *managed*
- Provide a "User's Manual" for building operation
  - Guidance for operating the building as a whole system, beyond that found in equipment manuals
- Engage the building user
  - Provide information describing the design intent and unique characteristics of specific design features to the building occupant
- Survey building users for occupant satisfaction

Process for Evaluating Progress

Criteria for Sustainable Success	✓ *Standard Practice/ Code-Compliant*	✓ *Better Performance*	✓ *High Performance for Sustainability*
Commissioning Activities	○ Federal and local codes for quality assurance	*PLUS:* ○ Commissioning plan, functional performance testing, and commissioning report	*PLUS:* ○ Comprehensive review of design and contractor submittals throughout the entire construction process
Commissioning Provider	○ None	○ Contract for commissioning agent as part of design or construction team	○ Contract for third-party commissioning authority
Operation Documentation	○ Construction as-built drawings and warranty documentation	*PLUS:* ○ Comprehensive O&M manual and preventive maintenance plan	*PLUS:* ○ Recommissioning management manual
Last Construction Process Step	○ Final contractor punch-out	○ Final commissioning report after staff training and building flush-out	○ Near-warranty end or post-occupancy review (i.e., 10 months into 12-month warranty period)
Continuous Commissioning	○ Reactive approach: examination of systems only when problems are reported	○ Active approach: effective maintenance with performance testing as resources allow	○ Proactive approach: scheduled recommissioning of all systems on a periodic basis

LANL Sustainable Design Guide

Los Alamos
NATIONAL LABORATORY

Link to the *LANL SDG*
http://www.eere.energy.gov/femp/techassist/sustainability.html

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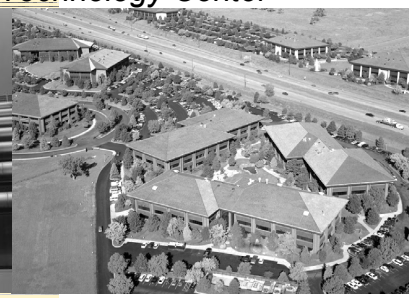
GENERAL DEVELOPMENT PLAN - 2003

Creating a "living laboratory" – a world-renowned, high performance research campus, exemplifying sustainability.

A 25-Year Development Plan for NREL's Campus at South Table Mountain and the National Wind Technology Center







National Renewable Energy Laboratory

NREL General Development Plan
Goals

To inspire world interest in RE/EE technologies and demonstrate sustainable design/environmental stewardship, we seek a cohesive and pedestrian-friendly campus with predominantly low-rise buildings, mixed use development, consolidated parking, and enhanced open space.

1. **Maximize** capability to support state-of-the-art R&D
2. **Ensure** safe, healthy, efficient secure operations while minimizing visibility of security
3. **Demonstrate** best principles of sustainable design
4. **Convey** NREL's image of excellence in R&D and sustainable design
5. **Maintain** positive relations with our neighbors

Sustainable Development at NREL

- *LANL Sustainable Design Guide*
- *NREL General Development Plan*
- Sustainable NREL
  - (www.nrel.gov/sustainable_nrel)
- *Greening Federal Facilities*
  - (www.eere.energy.gov/femp/techassist/green_fed_facilities.html)
- *Handbook for Planning and Conducting Charrettes for High-Performance Projects*
  - (www.highperformancebuildings.gov)
- High-Performance Buildings Research Initiative
  - (www.highperformancebuildings.gov)
- Solar Decathlon
  - (www.solardecathlon.org)
- FEMP Technical Assistance Team
  - (www.eere.energy.gov/femp)

Potential Sustainable Building Design Activities

- Develop template for sustainable building/site design that can be adapted to specific projects/campuses/regions
- Develop guidelines for incorporating sustainability in retrofit, decontamination, and deconstruction projects
- Provide workshops/training on sustainable design and planning to project design teams, facility managers, and other interested groups
- Partner with design teams of agency building projects to encourage inclusion of sustainable design strategies and implement sustainability objectives